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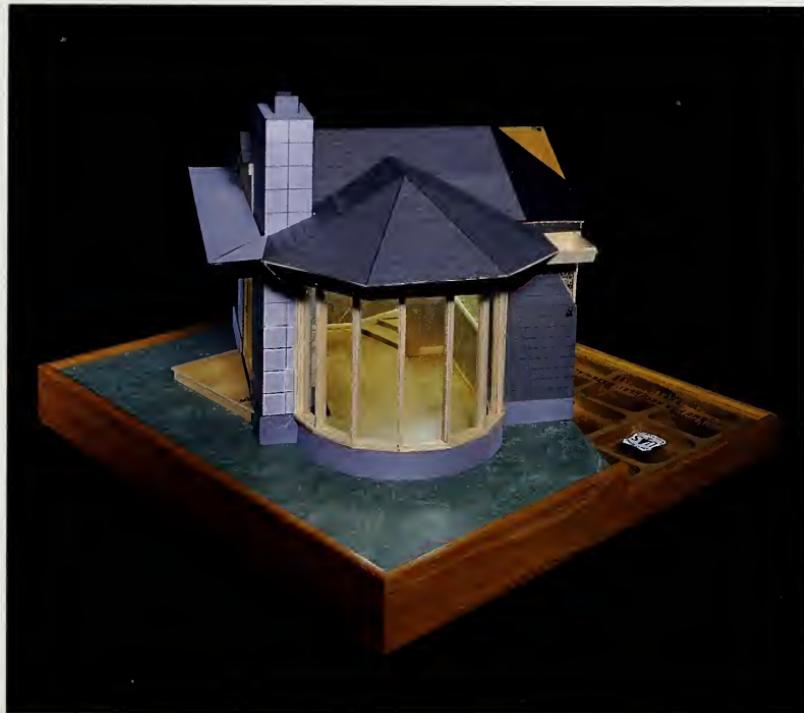
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## Housing: A Home for Recycled Materials

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U.S. Department of Agriculture  
Forest Service



A significant environmental challenge facing the United States is finding disposal and recycling methods for an enormous and ever-increasing accumulation of waste products. While nearly half of the Municipal Solid Waste Stream (MSW) is made up of wood waste and wastepaper, lack of markets is a major barrier to keeping these items out of the landfills.

A major potential market for recycling these materials is in products for housing and construction applications. In most new homes, very few of the available wood-based products consist of materials recovered from the municipal solid waste stream. Great potential exists for providing building products made from recycled wood waste and wastepaper as complements to those currently made from virgin material.

To help address this need, the USDA Forest Service has initiated a research program aimed at developing the technologies needed to create housing components from recycled materials. The goal is to provide technologies that will allow the use of recycled products for 20% of virgin wood material currently used in housing by the year 2000. This would provide markets for up to an additional 12 million tons of wastepaper and wood waste now going to landfills.

Potential applications for these technologies are described in the following paragraphs and illustrated in the model home shown in the cover illustration.

## **Model Home Components**

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### *Roof Systems*

Roof system components include reconstituted wood particles in sheathing, trusses, and rafters supplemented by solid wood structural elements to carry the snow, wind, and other loads. A sandwich panel made of recycled paper fiber provides structure and insulative spaces. Loose-fill cellulosic insulation is made of shredded demolition wood mixed with fiberized waste plastic. The roof includes recycled paper fiber in the roofing felt and concrete tiles with recovered materials as aggregate. The use of recovered materials could reduce the virgin wood fiber use in roof systems to 40% of present demands.

## *Exterior Walls and Siding*

Structural components for exterior walls include I-shaped columns that provide insulative spaces and composite sheathing panels that use recovered wood. Another structural system uses a recycled fiber sandwich panel with an insulative foam core. The interior wall coverings and sheathings demonstrate use of composites made from wood particles, gypsum, recycled fiber, and recycled plastics. Siding materials also show uses of recovered fibers and particles of wood along with plastics and inorganic binders. Exterior wall systems can be made using only 35% of the virgin wood fiber presently used.

## *Interior Walls*

The model home interior wall systems could replace all the solid-sawn wood materials used and play a significant role in supplementing most interior wall panels. Interior walls have "studs" made only from recovered materials. Extruded wood/plastic composite lumber and recycled paper made into rectangular components promise to provide the material and process alternatives to studs. Sound insulation and sound-deadening board for interior wall spaces can also be successfully produced from recovered materials.

## *Floor Systems*

The model home's floors use I-beam joists made from recycled fiber materials in the webs and virgin wood or laminated veneer in the top and bottom flanges. Thus, this reduces virgin fiber consumption to only 40% or less than what might have been used with solid wood joists.

The subfloor, underlayment, and finished floor of the model home use only recovered waste materials such as demolition wood, recovered plastics and recovered paper fiber. For kitchens and bathrooms, the wood aggregate floor is envisioned as tough, waterproof, and an excellent insulator.

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## Research Program Description



U.S. Department of Agriculture  
Forest Service

The USDA Forest Service's stewardship responsibilities include ensuring the wise and efficient use of the Nation's natural resources. As part of that responsibility, a Forest Service research initiative focuses on overcoming the technological barriers to reusing wastepapers and waste wood in a variety of products. Good progress is being made on recycling for paper production. This brochure describes a program that will increase the use of wood and fiber waste for housing construction. This creates jobs while dramatically reducing impacts on landfills.

The proposed research program concentrates initially on several key process technologies as they relate to the end product — recycled housing components. Research on performance evaluation and standards development, economics, and technology transfer rounds out the research program. Such studies are essential for these processes to become widely used commercially.

Potential building systems and components	Type of material					R = R&D needed
	Waste wood composites	Wastepaper composites	Wood/plastic composites	Wood/inorganic (cement) composites	Reused solid wood	
<b>Roof system</b>						
• Rafter/trusses	R	-	-	-	R	
• Sheathing	R	-	R	R	-	
• Shingles	-	-	R	R	-	
• Built-up roofing/felt	-	-	R	-	-	
• Decorative fascia	R	-	R	R	-	
• Insulation	-	-	R	-	-	
<b>Exterior walls/siding</b>						
• Exterior sheathing	R	-	-	R	-	
• Interior sheathing	R	-	R	R	-	
• Sandwich panels	-	R	-	-	-	
• Insulation	-	-	R	-	-	
• Framing lumber	-	R	-	-	R	
<b>Interior walls</b>						
• Framing lumber	-	R	R	-	R	
• Sound insulation	-	R	R	-	-	
• Paneling	R	-	R	R	-	
<b>Floor systems</b>						
• Joists	R	-	R	-	R	
• Sandwich panels	-	R	-	-	-	
• Underlayment	R	-	R	-	-	
• Flooring	-	-	R	R	R	
<b>Foundations</b>						
• Foundation blocks	-	-	-	R	-	
• Perm. wood foundation	R	-	-	R	-	
<b>Woodwork/finished components</b>						
• Molded trim	-	-	R	R	-	
• Ceiling tiles	R	R	R	R	-	
• Cabinets	R	R	R	-	-	
• Countertops	R	R	R	R	-	
• Furniture	R	R	R	-	-	
• Wall coverings	R	R	-	-	-	
<b>Exterior amenities</b>						
• Deck lumber	-	-	R	R	-	
• Retaining walls	-	-	R	R	-	

### Research program elements

- **Process technologies**
  - Waste wood composites
  - Wastepaper composites
  - Wood/plastic composites
  - Wood/inorganic (cement) composites
  - Reused solid wood
- **Performance evaluation and standards development**
  - Recycled products must meet accepted performance criteria, be environmentally safe, and be easily adaptable to building practices. This requires evaluation of characteristics which affect the in-place performance of these new products and building systems.
  - Design, testing, and evaluation standards must be established and implemented for material acceptance and use.
- **Economics**
  - Research is needed to integrate leading technologies and other research into business and the economy.
  - This includes evaluating (a) impacts on timber supply/demand and environmental quality, (b) economics of the technologies developed, and (c) overall life-cycle impacts.
- **Technology transfer**
  - Plays a critical role in the commercialization of recycling research for housing components.
  - Developing partnerships is an effective way to market these new recycled housing components.



The USDA Forest Service is uniquely qualified to lead a comprehensive recycling program requiring the involvement of government, industry, and academic partners. The Forest Products Laboratory (FPL) has the expertise and facilities for researching and developing housing components from recycled wood and wood fiber. Recycling research at FPL began over 40 years ago, to help conserve our Nation's resources. FPL also plays a critical role in the development of engineering design standards and building codes, with over 80 years of wood construction engineering design and performance evaluation experience. While the primary location of the research will be at FPL, scientists from several other Forest Service Laboratories and from universities will be an integral part of the program. State and Private Forestry, working closely with researchers, will concentrate on marketing and transferring recycling technology through its well established network of partners at the Federal, state, and local levels.



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## *Foundation*

Permanent Wood Foundation (PWF) systems, a viable outlet for treated waste wood, exploits the material's decay-resistant properties, and provides a use for this hard-to-dispose-of material. The components in a recycled PWF system could include particleboard and composite lumber.

Other options for treated wood include lightweight, high strength, wood cement composite blocks fabricated using recycled treated wood fiber as part of the aggregate. The fibrous nature of the wood increases the strength characteristics of the block, while lowering its weight.

## *Woodwork/Finished Components*

Molded wood trim products in the model home are manufactured using fiberboard cores and coverings of veneers, overlays, or paint. Sound deadening, high strength doors can be fabricated using spaceboard cores and molded wood products for door skins. Decorative countertops and cabinets can be fabricated from paneling made with construction wood waste, mixed waste paper and mixed waste plastic.

## *Exterior Amenities*

The use of plastic lumber has grown in recent years. Some manufacturers are improving plastic lumber through addition of waste wood or waste paper fiber to increase its stiffness and reduce costs. Additional technology must be developed to make wood/plastic composite lumber suitable for structural applications.

### **For further information, contact:**

Erv Schaffer, Assistant Director  
Forest Products Laboratory  
One Gifford Pinchot Drive  
Madison, WI 53705  
(608)231-9200

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Howard Rosen  
Forest Products and  
Harvesting Research  
USDA Forest Service  
14th & Independence, S.W.  
Washington, DC 20090  
(202)205-1565

